Health Assessment for

MIDWAY LANDFILL

NPL SITE I-87-158

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Agency for Toxic Substances and Disease Registry
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DRAFT HEALTH ASSESSMENT
FOR THE
MIDWAY LANDFILL
NPL SITE I-87-158
SEATTLE, WA

PREPARED BY

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SUMMARY

Midway Landfill is located in the city of Kent, WA, 15 miles south of Seattle. It is owned by the City of Seattle and was used for the disposal of landscaping refuse, construction debris, and small quantities of industrial wastes. The landfill was in operation from 1966 to 1983. The area surrounding the landfill contains mostly single family residences, with two elementary schools, at least one private school, and a city park.

An abandoned sand and gravel pit was chosen for the landfill site and because of the local stratigraphic sequence, lateral migration resulted in infiltration of methane into nearby structures. In addition to methane, the landfill gas contains some xylene, methylene chloride, benzene, and smaller quantities of chlorobenzene, ethylbenzene, and vinyl chloride. These constituents are also found in leachate from the landfill. Human exposure may result from subsurface gas migration, transport by groundwater, and by atmospheric transport.

Review of the currently available data indicates that the most important migration pathways for methane, xylene, methylene chloride, benzene, chlorobenzene, ethylbenzene, and vinyl chloride are subsurface gas migration and air transport. With the exception of methane and benzene, concentrations of the other volatile organic compounds (VOCs) found in the landfill gas do not appear likely to pose a public health concern.

Remedial actions taken by the city include a network of on-site gas migration control wells and off-site gas extraction wells. These remedial measures have reduced the threat of infiltration of landfill gas into nearby structures. If these measures are continued, the landfill gas should not pose a public health concern.

BACKGROUND

In 1985, city and state investigations found methane to be infiltrating homes and other buildings near the Midway Landfill. The landfill was placed on the National Priorities List (NPL) the following year, and a Remedial Investigation (RI) was initiated. Boundaries of the landfill property and the location of local industries, residencies, and public facilities are shown in Appendix A.

A. SITE LOCATION AND DESCRIPTION

Midway Landfill, located in the city of Kent about 15 miles south of Seattle, Washington, is a 60-acre tract of land situated between

Interstate 5 and the Pacific Highway (Washington Rt. 99). Deep ravines have been incised into the plateau by streams draining westward to Puget Sound and eastward to the Green River Valley. An extensive gravel quarrying operation was located at the site where the landfill is now located. The landfill is located near the Green River, west of the divide separating drainage of the Green River and Puget Sound.

Midway Landfill was opened in 1966 by the City of Seattle to receive wastes which decomposed slowly, such as demolition debris, wood waste, and landscaping refuse. In 1978, the landfill began to accept small amounts of industrial wastes which included liquid and sludge. The quantities and types of industrial waste were not recorded from 1978 to 1980. From 1980 to 1982, records indicate the following materials were disposed of in the landfill (Parametrix, 1988i):

Paint sludge
Dye and preservative waste water
Oily paint sludge
Waste coolant
Oily waste waters
Refinery tank bottoms
Lead-contaminated wastes

The landfill was brought to the attention of the county and city health departments as the result of complaints about noxious smells lodged by residents. Monitoring stations were installed upwind and downwind of the landfill in 1986 to assess the impact of gas emissions on the ambient air quality.

During landfill operations, approximately 3 million cubic yards of refuse were deposited. The landfill did not accept further refuse or waste after October 1983, and clean soil materials were imported to cover and grade the landfill. After closure, the landfill was capped with 6 to 24 inches of silt or fine sands, and 6 to 12 inches of clay were placed over areas where gas extraction wells had been installed (Parametrix, 1988a, 1988d). Following closure of the landfill, a network of subsurface gas sampling probes were installed around the perimeter, and groundwater monitor wells were placed in the interior of the landfill. Data collected showed the presence of highly mobile contaminants (principally methane and VOCs) at elevated concentrations within the landfill.

When the magnitude of the problem was recognized, Seattle and the Washington Department of Ecology moved to control the migration of gas away from the landfill and mitigate the off-site subsurface concentrations of methane. Between September 1985 and September 1986 the City of Seattle installed a battery of 32 gas-extraction wells around the landfill perimeter, in both refuse and native soil. Between November 1986 and December 1987, an additional 41

gas-extraction wells were installed, 39 in native soil around the perimeter of the landfill, and 10 within the landfill materials. Flares to burn off the gas have been installed in two locations within the landfill. Barometric and compositional gradients derived from off-site gas probe data gathered in early 1986 indicated that the gas migration control wells were not satisfactorily drawing the gas back into the landfill. Therefore, off-site extraction wells were placed in areas where methane concentrations were very high and where infiltration of gas into homes caused concern about fire hazards. At the present time, off-site gas probe data and home monitor data indicate that the off-site gas problem has been substantially abated, and all but 6 of the 19 wells have been shut off (Parametrix, 1988f).

The on-site migration control well system is expected to remain in operation until methane production in the landfill has decreased appreciably. Although gas production can be expected to continue for some time, the landfill is believed to have already passed through its maximum gas-production period (Parametrix, 1988f; Appendix G). Gas compositions are being monitored at the flares to evaluate their burn efficiency and impact on the local air quality.

B. SITE VISIT

On August 17, 1988, a site visit was conducted by the site assessment team from the Office of Risk Analysis, ORNL. The team members were accompanied by ATSDR personnel, representatives from the Washington State Department of Ecology, Department of Social and Health Services (DSHS), and the City of Seattle Engineering Department. Prior to the site inspection, a briefing was held to familiarize the team with the site history, health studies being carried out by DSHS, current remedial actions, and proposed actions to prevent leachate formation. The health studies consisted of: 1) a neighborhood illness survey and 2) a school absentee survey. The neighborhood illness survey did not show any correlation of elevated illness to known exposure, and the school absentee survey has not been completed. Copies of the EPA report and drafts of the state health studies were requested.

After meeting with the state representatives, the team was escorted to the landfill by representatives of the Seattle Engineering Department. The surface of the landfill slopes gently northward towards two boggy areas where runoff is reported to collect, forming shallow ponds during the rainy season. Near the boggy areas and along the eastern perimeter road, the land drops steeply, forming precipitous slopes. Presently, most of the landfill is covered by scrub, providing a habitat for quail and other small fowl and rodents.

During the visit both on-site and off-site monitoring and remedial facilities were inspected. On-site remedial installations are gas wells located around the perimeter of the landfill. The on-site wells

feed recovered landfill gas into a system of manifold pipes. Manifolds feed into a large electric manifold blower which in turn feeds the flare. The flares are enclosed by a high chain-link fence topped by barbed wire. Off-site remedial measures are gas extraction wells completed at depths between 60 and 100 feet. Off-site extraction wells are enclosed in a locked housing and attached to either a 1.5 or 5 hp electric motor.

The Pacific Highway which bounds the western edge of the landfill is zoned for commercial development and supports a wide variety of businesses including gas stations, dry cleaners, restaurants, and construction materials suppliers. A chemical transport company is located north of the landfill site. The transport company is being investigated by the EPA for possible violations of hazardous chemical handling regulations. Immediately south of the landfill, west across Pacific Highway, and east across I-5 are extensive tracts of predominantly middle class homes. A trailer park is located about 200 feet north of the landfill, south of a drive-in theater.

Construction of two, lined runoff retention ponds was underway when the site was visited. These ponds are being built as part of a leachate control plan. Presently, runoff from the I-5 corridor and the residence tract east of I-5 is directed to the landfill and contributes to leachate formation. The contribution to recharge from these two basins is estimated to be 20 million gallons per year. After the ponds are completed this source of infiltration will be eliminated.

After the ponds have been completed, the landfill property will be enclosed by a fence. However, at the present time the site is accessible to the public, and children have been reported on the property in the past.

ENVIRONMENTAL CONTAMINATION AND PHYSICAL HAZARDS

A. ON-SITE CONTAMINATION

The landfill gas and leachate generated in the landfill exhibit a variety of VOCs, albeit at low concentrations. The landfill gas is composed mainly of methane. Table 1 lists other contaminants and their concentration ranges in the landfill gas. The leachate has migrated downward into aquifers below the landfill. The concentrations of contaminants of concern in the leachate and lower aquifers are provided in Table 2. Surface water (when present) in two ponds north of the landfill is uncontaminated.

B. OFF-SITE CONTAMINATION

Subsurface gas samples from off-site probes contained elevated levels of methane, along with varying concentrations (in the low ppm range) of ethylbenzene, xylenes, and benzene (referred to as the "BTX group") and vinyl chloride. Elevated concentrations of methane, BTX compounds and vinyl chloride in subsurface gases are much more extensive east and southeast of the landfill, compared to north, south, and west of the landfill. Considering the small volume of gas and comparison of gas composition ranges in Table 3 to the air quality ranges in Table 4, it appears that that that venting of subsurface gas would not make an appreciable contribution to the benzene reported for air quality near the landfill. Table 5 summarizes the concentrations of contaminants in off-site groundwater.

C. PHYSICAL HAZARDS

The most serious potential hazard is the explosion of methane. Some homes as close as 120 feet to the landfill have been endangered in the past by this physical hazard. However, recent measurements in the basements of these homes have shown that the installation of extraction wells and gas migration control wells has cleared these structures of gases and substantially lowered the potential for fire or explosion

Table 1. LANDFILL GAS COMPOSITION

	Concentrations		No. of wells
	Maximum	Minimum	where detected
Methane (percent)	63%	(flare average)	ALL
Benzene	1.40	0.08	10
Methylene Chloride	2.65	0.88	2
Chlorobenzene	0.25	0.04	5
Vinyl Chloride	0.48	0.06	3
Total Xylenes	29.30	0.01	12

Concentrations are in parts per million by volume unless otherwise noted.

Table 2. ON-SITE GROUNDWATER CONTAMINATION

	Aquifer		
	Landfill (leachate)	Upper Gravel	Southern Gravel
Arsenic (in mg/l)	ND(.002)-.078	.06	.026
Benzene	6-15	4	ND(1)
Methylene Chloride	ND(5)-170	ND	ND
Chlorobenzene	ND(1)-71	10	ND
Vinyl Chloride	ND(1)-9	ND	ND
Total Xylenes	5-40	ND(1)	ND

ND = Not detected or detected but concentration below minimum quantification limit, the detection limit is given in parentheses. All concentrations are in ug/l unless otherwise noted.

Table 3. OFF-SITE GAS COMPOSITION

Chemical of Concern	Concentrations Maximum	Minimum	No. of wells where detected
Methane	78.0%	25.0	All
Benzene	0.19	0.04	10
Methylene Chloride	2.49	2.08	2
Chlorobenzene	0.06	-	1
Vinyl Chloride	0.28	0.05	4
Total Xylenes	0.11	0.01	16

Concentrations are in parts per million by volume unless otherwise noted.
- = Undetected, detection limit not given.

Table 4. AIR QUALITY AROUND THE MIDWAY LANDFILL.

	Upwind ppb MAX	MIN	Downwind ppb MAX	MIN	Off axis ppb MAX	MIN
Benzene	15.8	1.7	5.8*	0.1	1.9	0.0
Methylene Chloride	0.4	0.0	1.2	0.0	45.2	0.0
Chlorobenzene	U		U		U	
Vinyl Chloride	U		U		U	
Total Xylenes	3.0	1.2	10.0	0.0	2.0	0.0

U = Undetected, parts per billion by volume.
*A higher value of 22.5 was rejected because of the poor quality of the analysis.

Table 5. OFF-SITE GROUNDWATER CONTAMINATION

	Aquifer Upper Gravel	Sand	Northern Gravel	Southern Gravel
Arsenic (in mg/l)	ND	ND	ND	ND
Benzene	ND-16	ND-0.2	ND	ND-16
Methylene Chloride	5-120	ND-30	ND	ND-7
Chlorobenzene	ND-10	ND-6	ND	ND
Vinyl Chloride	ND	ND-20	ND	ND-6
Total Xylenes	ND-120	ND-22	ND	ND

ND = Not detected, see Table 1 for detection limits.

DEMOGRAPHICS OF POPULATIONS NEAR THE SITE

A. POPULATIONS AT RISK

In general the population which could be adversely affected by emissions from the landfill or infiltrating gas are those people who reside in the area surrounding the landfill. For the impact area defined in the RI, 1980 census data indicate a total population of 6430 living in 2263 housing units. The population is estimated to have increased 28% to 8230 since 1980. The proportion of that population in high risk groups (e.g., 0-4 or over 65 years of age) was not available. A second population which may be at risk are children who live outside the impact area but attend school or day care nearby. The number of children that fall into this second group is also unknown.

The landfill gas is known to have migrated up to 2600 feet from the landfill. Therefore, the impact area can be defined as a block 2600 feet wide. It is important to add that, at this time, remedial actions implemented by the city and state have substantially reduced the hazards associated with the landfill (Parametrix, 1988f), thereby reducing the number of households affected by the landfill gas.

Remedial actions which are being taken may expose workers to landfill gas. Exposure may occur during installation and maintenance of gas-migration-control wells, because of incomplete combustion of gas at the flares, or from leaks in the gas manifolds.

B. LAND USE

The land surrounding the Midway Landfill is predominantly used for single family residences, education and public recreation. However, commercial concerns are located along the Pacific Highway. The map in Appendix A (Parametrix, 1988e) delineates the general land uses around the landfill. There are two elementary schools, at least one private school, and a city park within a half-mile of the landfill. A community college is located three quarters of a mile northwest of the site. Most of the land surrounding the landfill is developed, but there are also numerous tracts of vacant land, some bordering the landfill to the northeast.

Of the 166 businesses within a one-mile radius of the landfill, there are 15 restaurants and bars, six retail stores, and a number of light industries, including dry cleaners, boat manufacturers, auto-repair shops, gas stations and one abandoned chemical-transport company.

EVALUATION

A. SITE CHARACTERIZATION (DATA NEEDS AND EVALUATION)

1. Environmental Media

The chemical characterization of groundwater, surface water, and air quality appears to be adequately delineated for evaluating the impact of the landfill on human health. The data available for soil is clustered around the Parkside wetlands and does not bear directly on contamination at the landfill, and soil data from the site itself are absent. However, because of the silt and clay covering the landfill and the limited quantity of potentially hazardous materials disposed of in the landfill, the available soil data are judged adequate for determining the extent of soil contamination.

2. Demographics and Land Use

The data summarized in the RI were very complete and included a forecast analysis of demographic trend data. The RI characterized the surrounding population and land use patterns in a telescoping fashion allowing evaluation of the impact of the landfill on both the immediately surrounding area and the region.

3. Quality Assurance and Quality Control

Concentration data provided were carefully scrutinized for accuracy and validity. The sampling procedure as described in the RI included field, sample, and laboratory blanks to evaluate sources of contamination. Replicate and duplicate samples were taken to assess the accuracy and precision of the analyses. The duplicate and replicate analyses were included in the reports, and the presence of toluene, acetone, methylene chloride and benzene (albeit in very low concentrations) in the blanks was noted. In groundwater analyses, where a compound was detected or suspected of being present, the detection limit was reported and the uncertainty indicated.

B. ENVIRONMENTAL PATHWAYS

The environmental pathways of contaminant migration identified for the Midway Landfill are: 1) subsurface gas transport; 2) transport of contaminants by groundwater flow, and 3) air dispersion of VOCs from venting of the landfill gas and from gas flares. Surface water and off-site soils do not appear to be contaminated; therefore, transport or transformation mechanisms of contaminants in these media are not considered.

Air

West and southwest are the most frequent year-round wind directions, but there are some appreciable seasonal differences. The predominant wind direction during the dry season is from the west and from the east in winter and autumn. Wind speeds are generally 3 to 10 mph, and the air is calm only about 5% of the time.

There are two main sources of landfill-related air contamination: a) escape of VOCs from the gas flares and b) venting of subsurface gas. From comparison of upwind and downwind ambient air data, it appears that the downwind concentrations of airborne contaminants are can be lower or equal to upwind levels (see Table 4). Thus, while air transport and dispersal may be an important environmental transport pathway, emissions from the landfill do not appear to have an appreciable impact on the ambient air quality.

Subsurface Gas

Data collected from the off-site, shallow gas probes (installed by the Washington State Department of Ecology) and the home-gas monitors (installed by the City of Seattle) indicate that methane was detected in utility conduits and in homes up to 2600 feet east of the landfill. Concentrations of BTX group contaminants in subsurface gas samples from off-site locations appear to be reduced in comparison to on-site samples.

Combustible gas was detected in homes at levels approaching 100 ppm; however, the VOC component of the gas was greatly reduced from the levels found at the landfill. The gas appears to have migrated away from the landfill via the unsaturated zone of unconfined aquifers below the landfill. Migration of the gas was driven by the positive pressure generated in the decomposing waste pile and a barometric pumping action created when storm cycles passed over the area.

Groundwater

At least four aquifer systems can be defined: 1) seasonal or transient water tables in the recent alluvial deposits and sediments related to the Vashon Glacial Epoch; 2) the Upper Gravel Aquitard and aquifer in the outwash gravel; 3) the Sand Aquifer in deltaic sediments, and 4) two gravel aquifers (the Northern and Southern) in the lower most stratigraphic unit. The unsaturated portion of the upper gravel aquifer and the seasonal water tables appear to be the main avenues for gas migration away from the landfill.

Because of the discontinuous character of the stratigraphic units, and consequently of the aquifers underlying the landfill site, the groundwater flow is poorly understood. Hydraulic gradients in the upper two aquifers beneath the landfill are to the south or southeast, even though the land surface slopes gently north or west toward Puget Sound (Parametrix, 1988b). Piezometric surfaces of all aquifers in

the area lie at successively lower levels indicating recharge of lower aquifers by higher ones. The upper gravel aquifer is unconfined and intersects the base of the landfill, providing a primary environmental pathway for off-site migration of landfill gases (Parametrix, 1988e).

Leachate from the landfill contains some contaminants at levels which exceed drinking water standards. In comparison to the regional groundwater composition, the leachate is highly saline (7.2 mg/l and 1230 to 1770 mg/l Cl (chloride), respectively). Because the chloride level in the leachate is much higher than in groundwater, the chloride concentration was used to trace the migration direction and impact of the leachate. The chloride concentration in groundwater decreases below the landfill in each lower stratigraphic or hydrologic unit but is still elevated (147 mg/l) 300 feet below the landfill (MW-19c). This indicates that all of the hydrologic units receive recharge from immediately higher units.

The piezometric surfaces, and consequently the direction of water flow of the three confined aquifers, are appreciably different from one another. The Upper Gravel Aquifer is discontinuous and constricted at the location of the landfill. Groundwater flow appears to converge from the north and south below the landfill in the Upper Gravel Aquifer. Streamlines converge on the landfill site in the underlying Sand Aquifer also, but flow appears to exit towards the east-southeast. Some residents in the Lake Fenwick area southeast of the landfill use groundwater for drinking water and groundwater flow in the sand aquifer appears to be in this general direction. Data provided in the RI indicate that most contaminants found in leachate at the landfill are either not found in groundwater downgradient from the landfill or are found at greatly reduced concentrations. The attenuation of the chloride concentration in groundwater downgradient from the landfill (see Off-site Contamination Section) suggests that any contaminants present in the groundwater will be attenuated to levels substantially below levels likely to be of public health concern.

The environmental pathways which would provide exposure of humans to contaminants derived from the landfill are migration of landfill gas and contaminated groundwater. Concentrations of VOCs in both groundwater and subsurface gas decrease away from the landfill.

C. HUMAN EXPOSURE PATHWAYS

The principal route of exposure to contaminants in the vicinity around the Midway Landfill would be via inhalation of methane or VOC-laden air or ingestion of contaminated groundwater. Of the potentially exposed populations and exposure pathways listed in Table 6, the exposure routes most likely to be complete are those involving remedial activity workers.

Table 6. Exposure Pathways Evaluation

Medium	Potentially Exposed Population	Exposure Pathway
Landfill Gas	Adjacent residents	Inhalation
	Remedial workers	Inhalation
Groundwater		
On-site	Remedial workers	Dermal contact Secondary inhalation*
Off-site	Adjacent residents	Dermal contact Secondary inhalation

* Secondary inhalation = inhalation of contaminants volatilized from the soil or groundwater.

Levels of VOCs in the ambient air around Midway are high but not necessarily totally attributable to the landfill. Exhaust from vehicular traffic on the highways both east and west of the landfill may augment the contaminant concentrations in the ambient air around the landfill. Inhalation of ambient air containing VOCs represents the human exposure pathway most likely to occur.

There are no known wells used for drinking water in the area within the impact area defined by Parametrix (1988d,e); however, the Lake Fenwick area does draw drinking water from the Southern Gravel Aquifer and lies a couple of miles downgradient from the landfill. Presently there are no known drinking water wells which are affected by leachate from the landfill (Parametrix, 1988a). Provided that this information is correct, there are no receptors of contaminated groundwater.

Because of remedial actions taken by the city and state, infiltration of off-site structures by landfill gas is no longer occurring. Therefore, this exposure route has been eliminated from concern. Concentrations of VOCs in the landfill gas at the site are well below the time weighted average (TWA) limit for occupational safety and do not pose a threat to the remedial action workers.

PUBLIC HEALTH IMPLICATIONS

Methane, the principal constituent of the landfill gas, is a combustible gas and an asphyxiant. Exposure to atmospheres containing high levels of methane results in a feeling of shortness of breath, dizziness, and, if prolonged, death by suffocation. In addition to the health threat posed by direct exposure, there is also the threat of fire or explosion.

There are other components of the landfill gas which may pose a threat to public health, most notably benzene. The worst case exposure due to inhalation of landfill emissions is predicted to occur at the southern site boundary under stable atmospheric conditions accompanied by wind speeds of less than 3 knots (conditions expected only 2% of the year) (Parametrix, 1988g,h). Under these conditions, the available data suggest that air emissions from the landfill will have no adverse impact on human health. However, the levels of benzene in the ambient air (maximum concentration: 15.8 ppb), may present a potential public health concern, including the potential of elevated risk of long-term carcinogenic effects. The primary effects of inhalation of benzene are on the central nervous system. Symptoms include headache, dizziness, drowsiness, and nausea. Benzene may also cause irritation of the eyes and skin.

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Based on the information reviewed, ATSDR has concluded that this site is not of public health concern under present conditions because of the absence of appreciable levels of hazardous substances. As noted in the evaluation of Environmental Pathways and Human Exposure Pathways Sections above, there is no evidence of appreciable human exposure attributable to the Midway Landfill. However, if the remedial actions presently in place are compromised, fire or explosive hazards may develop in some of the nearby structures, or at the landfill.

B. RECOMMENDATIONS

1) ATSDR recommends that remedial actions presently being undertaken by the City of Seattle be completed. The remedial actions already in place have reduced the problems associated with infiltration of landfill gas into nearby structures. While groundwater quality appears to be affected by infiltration of leachate, the planned runoff retention ponds will markedly reduce the generation of leachate.

2) ATSDR also recommends that the groundwater monitoring program be continued to track the migration of groundwater affected by the leachate.

3) In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 as amended, the Midway Landfill site has been evaluated for appropriate follow-up with respect to health effects studies. Inasmuch as there is no extant documentation or indication in the information and data reviewed for this Health Assessment that human exposure to on-site and off-site contaminants at levels likely to be of public health concern is occurring, this site is not being considered for follow-up health studies at this time. However, if data become available suggesting that human exposure to appreciable levels of hazardous substances is currently occurring, ATSDR will re-evaluate this site for any indicated follow-up.

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